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GROUP II

Method for flow-pressure control and monitoring of constant or variable volume air-fluid distribution systems, terminal devices and prime movers.

I claim:

1. A method for flow-pressure control and monitoring of constant or variable volume air-fluid distribution systems, terminal devices, and prime movers where steps of the method include

establishing mover x/y values through any speed of rotation and degree of wide open mover flow curve;

establishing terminal device x/y values through any degree of closure and Total Pressure constant;

coordinating flow-pressure data through plotted curves of primary mover, system, and terminal device performance characteristics;

processing output signals from flow-pressure monitor stations;

interpolating these signals through the processor,

where sensed x/y (volume/pressure) values are coordinated to depict the actual operating point of the mover-system to that assigned on the Cartesian graph;

displaying the intended operating point as juxtaposed next to where sensors indicate actual values exist so that an output to a panel display may be observed for comparison.

2. The method of claim 1 wherein the mover driven RPM is metered to establish in memory the mover constant with corrected BHP obtained from current readings of the electric motor powering the mover.

3. The method of claim 1 wherein the mover curve is plotted along its exact driven RPM against a given system or some load with resistance where x/y (volume/pressure) are assigned values;

and displaying the operating point indicating where the system curve intersects with the mover curve or valve constant;

at a given pressure and flow-volume as monitored by the prime mover sensor station for the system total;

at a given pressure and flow-volume as monitored by the terminal device sensor station for its terminal branch run for the system terminal.

4. The method of claim 1 wherein the system curve is plotted at one or more mover speeds or valve constants to establish additional verification points for plotting the extent of the system curve or sub-system curve.

5. The method of claim 1 wherein mover performance curves and system curves are projected by affinity relationships where no other data is made available when there are missing links in the curve;

by plotting one or more additional coordinates of the system where the x value (flow) is squared to the y value (pressure);

by plotting one or more additional coordinates of the mover curve where the mover rpm is cubed to its corrected BHP (y value).

6. The method as in any of preceding claims 1-5 serving automatic or default mode, the method including the steps wherein

mover x/y values are established through any speed of rotation and degree of wide-open mover flow curve;

mover speed control is effected to adjust the actual x/y values of the primary mover constant against the system constant as per total and specific pressures sensed versus target operating point designated;

damper x/y values are established through any degree of closure and Total Pressure constant;

damper actuation is effected to adjust the actual x/y values of the valve constant against its sub-system constant as per total and specific pressures sensed versus target operating point designated;

and stop or start motor speed control or damper control actuation to approach the coordinates of the intended operating point;

placing the actual operating point where designated, or within its own suggested operating range;

adjusting the actual operating point x/y values to meet in closest measure those coordinates of that operating point targeted.

7. The method of claim 6 wherein

when Total Pressure (TP) is lost or gained as monitored by the primary mover's flow-pressure monitor station, the variable mover increases or decreases rotational speed to

adjust this measure in exact proportion to what was lost or gained, using its Total Pressure sensors, its Static Pressure sensors, or its Velocity Pressure sensors as appropriate.

8. The method of claim 2 or 7 wherein

a comparison is drawn of electrical Total Wattage as it parallels Total Pressure and the y value is calibrated by calculated BHP as obtained from current readings of the electric motor operating the primary mover with corrective calibration of the y value or y factor along the mover curve, and corrective calibration of the mover curve therewith.

9. The method of claim 1 wherein the x value is adjusted to ride the plotted system curve with any increase in y value (or changes to the mover) so increase is not directly related or vertical;

where value changes to a mover constant or a system constant, but not both, ride the other's curve;

where either x or y values are adjusted to stay along these tangents (x/y or y/x).

10. The method as in any of preceding claims 1-5 serving terminal device automatic or default mode, wherein

damper x/y values are established through any degree of closure and Total Pressure constant;

modulating the terminal device damper-actuator within a distribution system to either open or close with net pressure gains/losses, and

placing its own sub-system operating point on target with its valve constant or in the suggested operating range as per design or previously set criteria.

11. The method as in any of preceding claims 1-5 operating in a Variable Volume System with a plurality of terminal devices wherein

the Initial Point of Operation and range parameters are established through flow-pressure monitor sensor input when:

the primary mover is started and sped to its target maximum rpm setting at the designated total flow-volume as monitored at the main flow station;

all variables are indexed to their starting maximum positions and the maximum critical run operating point on the system curve display is marked off on the graph;

the primary mover is then slown to its target minimum rpm setting;

all variables are indexed to their minimum positions and the minimum critical run operating point on the system curve display is marked off on the graph;

and a total system cutoff or constant is established for the entire operating range of the variable speed mover and its variable system, outlining an effective range and critical boundary of variable mover-system performance.

12. Furthering the method of claim 11, during Variable Volume System operation, wherein

variable operating parameters and point of operation are tracked and adjusted automatically, whereby mover and terminal devices modulate to constant settings, varied settings, or default (suggested) settings;

by sorting terminal runs from least to most critical by way of flow-pressure sensor input values from a plurality of terminal devices throughout a distribution system;

by placing those terminal devices and their runs most critical in their suggested ranges or maximum positions as necessitated;

and applying mover power to maintain adequate Total Pressure against a required flow rate to any terminal device that becomes most critical under modulation;

and placing those terminal devices and terminal runs least critical in the percentile amount designated for system diversity;

and placing those terminal devices and terminal runs least critical in their minimum or closed positions;

and by allowing mover-terminal operation to remain only within established boundaries or suggested operating ranges.

13. The method of claim 12 wherein the primary mover applies a “Mover Total Pressure” against a terminal device Total Pressure loss.

14. The method of claim 12 wherein the primary mover applies a “Unit Total External Pressure” against a terminal device Unit Total External Pressure loss.

15. The method as in any of preceding claims 1-5 serving the mode of Series Operation where steps include

activating a secondary mover in series or a secondary damper in series with the distribution system when system velocity increases (Vp) occur as would be caused by an opening damper, valve, or bypass-relief on a terminal branch;

throttling the the main damper control to create an artificial Static Pressure increase to meet and maintain the deviated operating point against its incremental x/y value or y value (SP) alone as sensed at flow-pressure monitors.

16. The method as in any of preceding claims 1-5 serving the mode of Parallel Operation where steps include

activating a secondary mover in parallel, a secondary damper in parallel, a relief opening, a bypass, or a secondary source of flow in parallel with the distribution system when system static increases (SP) or Static Regain occurs and, thus, a dynamic decrease;

thus meeting and maintaining a deviated operating point against its incremental x/y value or x value (Vp) alone as sensed at flow-pressure monitor stations.

17. The method of claims 15 or 16, wherein

when Total Pressure (TP) is lost or gained as monitored by the primary mover's flow-pressure monitor station, the variable mover increases or decreases rotational speed to adjust this measure in exact proportion to what was lost or gained, using its Total Pressure sensors, its Static Pressure sensors, or its Velocity Pressure sensors as appropriate.

18. The method as in any of preceding claims 1-5 where the said method serves a user interactive mode of operation wherein data is manually entered,

adjusting x/y values corresponding to flow-pressure sensor values;

programming and placing the point of mover-system operation where desired by user intervention;

effecting motor RPM and/or motorized damper control on command to specifically alter x/y coordinates of the operating point or points;

to design, test, calibrate, or operate a constant or variable volume system;

to view output display data of mover, system, terminal device, or heat transfer performance for observation, testing, design, estimation, or any other purpose.

19. The method of claim 18 wherein

the system may be manually altered, fitted, or re-fitted to relocate the operating points or operating parameters.

20. The method as in any of preceding claims 1-5 wherein

an open input port to the processor receives input from zone sensors or other external input to effect motor control of mover or terminal devices as per local network or thermostatic control,

thus activating motor control in the mover or terminal device and placing the system or sub-system in its appropriate point of operation as required or set by default, temperature or other set point.

21. The method of claim 19 wherein diverging or expansion fittings are ducted to any mover to increase system Static Pressure;

and wherein converging or reduction fittings are ducted to any mover to increase system Velocity Pressure;

and wherein straight, diametrical fittings are ducted to increase length of run distribution effective to Total Pressure.

22. (Amended to fit Grouping) The method of claim 21 wherein an axial mover is ducted to a diverging or expansion fitting member with a dampering device situated at the point in the system of peak static regain or otherwise adjusted to optimal mover and valve constants, thus achieving peak system pressure and BHP with minimal Vp losses.

23. The method of claim 21, wherein the diverging or converging fitting geometry befits any mover's Total Pressure, whereby

the diverging fitting meets the mover's net static power through effective duct diameter dimensional data;

whereby the converging fitting meets the mover's net velocity power through effective duct diameter dimensional data.

24. The step of maintaining adequate Total Pressure of claim 12, wherein TPR (Total Pressure Required) is monitored against its actual value, TPA (Total Pressure Available) at each terminal flow control device sensing station, using only TPA in whatever amount available;

and modulating damper/valve position if TPA exceeds TPR at a given set point;

and maintaining damper/valve position at TPR set point for pressure independent operation (independent of the total system) under changing system conditions and changing valve constants until TPA drops below this point.

25. The method of claim 16 where under parallel damper operation, the secondary parallel damper and additional flow source provide a cumulative velocity, traversing fitting and directional losses.

26. The method of claim 15 wherein the primary damper may provide critical run leverage by generating static pressure in conjunction with forced mover application through motor-drive speed control, thus maintaining adequate Total Pressure.

27. The method of claim 1 wherein leakage rate and quantity, or undue flow and quantity are deducted

by noting x value changes in the system curve plotted against any mover or terminal device and its respective system or sub-system reflecting relative increases in Velocity Pressure and, conversely, decreases in Static Pressure as deducted from Total Pressure.

28. The method of claim 1 wherein undue restriction and quantity may be deducted

by noting y value changes in the system curve plotted against any mover or terminal device and its respective system or sub-system reflecting relative increases in Static Pressure and, conversely, decreases in Velocity Pressure as deducted from Total Pressure.

29. The method of claim 1 wherein leakage testing operation may proceed by increasing mover speed and

throttling the terminal device damper-actuator until static sensor input reaches the entered value of the duct rating;

stopping where SP and Vp solitary curves experience level off;

determining the exact percentage of Vp content as noted in sampled or real time flow-pressure readings;

displaying SP and Vp solitary curves with level-off plateaus, where each gradient is required to remain constant under testing conditions;

converting the Vp figure to FPM units across the adjusted area of only that section being isolated for testing to establish CFM leakage flow rate.

30. The method of claim 1 wherein leakage testing operation may proceed by control damper throttling and mover application;

bringing system Static Pressure level up to the ductwork rating and isolating its velocity gradient;

displaying plotted system curves with actual operating points;

and calculating comparative data noting specific deviations from those operating points intended.

31. The method of claim 27 wherein leakage testing operation may proceed by

deducting the leakage factor under any given system conditions through specific Vp gradient deviations from known OP's that cannot be attributed to undue flow.

32. The method of claim 1 wherein the interior volume of a given vessel or enclosure may be determined by instant reading whereby

a free flow rate is sampled prior to encountering total net static pressure;

marking this cutoff point in memory;

performing a calculating step to determine the interior volume of standard air passing this pivotal point through CFM flow-volume unitary measurement.

33. The method of claim 32 wherein the method establishes the system curve of a vessel or enclosure through precise instant flow readings using flow pressure sensing stations.

34. The method of claim 33 wherein free flow rate is monitored until build up of static resistance causes it to begin to cease;

marking in memory this exact cutoff point, wherein flow encounters maximum resistance - or total *static* power of the primary mover;
deriving the exact flow-volume rate that passed the metering device from CFM units, after Vp is converted to FPM.

35. Furthering the method of claim 34, wherein the function will continue to monitor any static and dynamic factors present after the vessel has been filled to its full interior volume,

or more indicatively, when the primary mover has reached its total static power, *less* the total static drop of the metering device, *less* any Vp which may exist in the form of leakage leaving the vessel at a steady rate.

36. The method of claim 32 wherein ACH (Air Changes per Hour), ACM (Air Changes per Minute), or any unitary measurement of air-fluid changes occurring within a vessel, compartment, or enclosure is determined through applying the desired time frame to each complete change of volume constituting one standard change or any corrected change occurring above or below atmosphere.

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